ORIGINAL ARTICLE

Functional outcomes of pediatric true and equivalent Monteggia fractures – Review of the literature

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ABSTRACT

BACKGROUND: This study aims to describe the functional outcome of true and equivalent Monteggia fracture-dislocations in the pediatric population. We also provided a review of the literature about the treatment options.

METHODS: Five surgically and three conservatively treated patients were identified who were treated in 2009-2021. The study population consisted of six female and two male patients. The mean age at the time of treatment was 7. The mean follow-up time was 55 months (range, 12–128). The Mayo Elbow Performance Score and the Oxford Elbow Score were used for outcome evaluation. Range of motion and grip strengths were also evaluated.

RESULTS: There were two Bado type I and six Monteggia equivalent injuries. Closed reduction and casting were utilized for the two Bado type I injuries as the initial treatment. However, one had a radial head re-dislocation and had to be treated operatively. This patient had a radial head re-dislocation after the surgery and was followed up conservatively. Three Monteggia equivalent injuries were treated with closed reduction and casting, with no complications. One patient had a radial head anterior dislocation with plastic deformation of the ulna, and this patient was managed with CORA-based corrective ulnar osteotomy. For Monteggia injuries, the main treatment objective is to restore the ulnar length. Bilateral computed tomography imaging with 3D reconstruction can be utilized in preoperative planning of Monteggia fracture-dislocations to customize the treatment. Close observation is essential to detect radial head subluxation, which needs early intervention before irreversible changes occur.

CONCLUSION: The true/equivalent Monteggia fractures' main treatment goal is to restore the ulnar length. Conservative treatment, with a close follow-up, is the first option if closed reduction can be achieved. If closed reduction is not possible, careful preoperative planning and early rehabilitation are key to success for management of Monteggia fractures.

Keywords: Monteggia; Monteggia equivalents; pediatric fractures; upper extremity deformity.

INTRODUCTION

Giovanni Battista Monteggia first described Monteggia fracture in 1814 on two ulnar shaft fracture cases with concomitant anterior dislocation of the radial head.[1] With further understanding, not only ulnar fracture but also traumatic bowing associated with radiocapitellar and proximal radioulnar joint dislocation is now also considered Monteggia fracture. While being a rare injury with an incidence of 1% of all pediatric forearm fractures,[2] the literature was mainly focused on treating neglected cases and complications of the treatment modalities. To optimize the treatment modalities, Bado suggested a prior classification system according to the direction of radial head dislocation. Later, Bado added the

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Monteggia equivalent injuries, which are similar in trauma mechanism but differ entirely in treatment, which caused concerns in the literature.[3,4]

Due to their unstable nature,[4] these fracture-dislocations tend to dislocate even after proper reduction. Consequently, close observation is recommended. The treatment's primary goal is based on restoring the forearm length. Still, minor issues could result in re-dislocations, resulting in decreased pronation/supination and disruption of carrying angle, thereby reducing strength. In some cases, a dislocated radial head may not cause any symptoms; as a result, erroneous healing that will prevent reduction may occur in this pediatric population. To prevent this complication and maintain the reduction, annular ligament repair, Bell-Tawse procedure, and ulnar and radial osteotomies have been suggested, but a consensus has not been established due to the rarity of this injury.[5,6]

The most reported complications in the literature were irreducibility, re-dislocation of the radial head, loss of fracture reduction, and posterior interosseous nerve palsy. Previous studies reported a wide range of re-dislocation rates and multiple factors that preclude proper reduction. Annular ligament incarceration and buttonholing of the radial head were the most common causes of irreducibility, whereas re-dislocation was most commonly due to the failed restoration of the forearm length. Nonetheless, the timely intervention of the acute fractures and embracing the correct strategy for neglected cases result in a good prognosis, with no significant limitation of range of motion.[7,8]

This study aims to describe the clinical outcomes of our eight patients: five treated surgically and three conservatively. We also present a review of the current literature on Monteggia fractures and its equivalents in the pediatric population.

MATERIALS AND METHODS

Our study methodology was designed according to the 1964 Helsinki Declaration and its later amendments. After obtaining approval from the Institutional Review Board, medical records were searched for Monteggia and equivalent fractures. Five surgically and three conservatively treated patients were identified between 2009 and 2021. Patient demographics are presented in Table 1. All patients were invited to the hospital for a final follow-up evaluation, and all agreed to participate in our study.

Our population consisted of six female and two male patients; their mean age at the time of treatment was 7. The right arm was involved in four cases, and the left was involved in four patients. In three cases, the dominant arm was injured. The mean length of follow-up was 55 months (range, 12–128 months).

The Mayo Elbow Performance Score (MEPS) and the Oxford Elbow Score (OES) were used for outcome evaluation. MEPS is a clinician-based score and questions the pain status, range of motion, elbow stability, and functionality of the patient with a maximum value of 100, which means the best outcome. OES is a 12-item patient-reported outcome measure with a maximum value of 48 being the best outcome and questions the pain status, daily life activity interferences, and socio-psychological impact of the injury.

The range of motion was evaluated with the help of a goniometer. The grip strength of the patients' forearms was assessed via an electronic hand-held dynamometer (Jamar, IL, USA). Peak grip strength values were recorded with the wrist in pronation, supination, and neutral position, with three attempts for each. Orthogonal radiographic images were also obtained to assess the final status of the radial head and the ulna's alignment.

RESULTS

The patients were invited to the outpatient clinic for a final evaluation of functional outcome, grip strength, and range of motion. All patients were available for a follow-up with a mean of 55 months (range, 12–128 months), and the duration of the follow-up is shown in Table 1. Our series consisted of two Bado type I and six Monteggia equivalent injuries. The mean age was 7.5 years (range, 6–11). The left side was involved in four cases. Four patients were treated with closed reduction and casting at the initial admission.

Case 1 had Bado Type I Monteggia injury treated in the first 24 h of her trauma (Fig. 1a and b). The anatomical reduction was achieved with closed reduction, and a conservative treatment pathway was chosen (Fig. 1c and d). Six weeks later, during routine follow-up, radial re-dislocation was detected, most likely due to the shortening and remodelization of the ulna or buttonholing of the radial head (Fig. 1e). Bilateral 3D computed tomography (CT) scanning was performed to understand rotational deformity, and CORA-based ulnar osteotomy, overcorrection, and plate fixation were performed (Fig. 1f and h). However, the radial head spontaneously dislocated again 3 months after the surgery [Fig. 1i and j]. Revision surgery was suggested, but the patient did not have any significant functional deficiencies; also, no limitation in motion or sports activities was present, the family refused the operation despite possible future weakness, and rotational limitations were discussed thoroughly. After 1 year of follow-up, the patient's family requested the removal of the implants (Fig. 1k). Again, the option of revision was suggested, but the family declined an additional incision, and the follow-up was pursued (Fig. 2).

Case 2 also had Bado Type I injury. Due to its transverse ulnar fracture pattern, closed reduction and casting were performed on the day of trauma. Close follow-up was initiated, and no subluxation was observed at the end of the 1-year follow-up.

Table 1. Overview of the cases

Serial number	Age (year)	Sex (m/f)	Bado type	Dominant side	Injured side	Type of ulna fracture	ROM-left	ROM-right	MEPS	OES	Grip strength (kg) supination/pronation/ neutra (months) (left, right)	Treatment	Follow-up
1	6	Female	Bado I	Right	Right	Ulnar oblique fracture with anterior dislocation of radial head	0/130–90/90	−5/140–90/90	95	46	Left - 8.1/7.5/7.1 Right - 7.1/7.3/7.0	CR and casting Operated in 6th week Re-dislocation	99
2	7	Female	Bado I	Right	Right	Transverse ulnar shaft fracture with anterior dislocation of of radial head	0/145–90/90	0/145–90/90	100	48	Left - 8.2/7.9/7.5 Right - 7.8/7.5/7.3	CR casting	12
3	6	Female	Equivalent	Right	Right	Isolated radial neck fracture	−5/145–90/90	0/145–90/90	100	48	Left - 8.3/8.6/8.1 Right - 9.2/9.0/8.6	CR/IEN† (Metaizeau Technique)	98
4	11	Female	Equivalent	Right	Left	Isolated radial neck fracture	0/145–90/90	−5/140–90/90	100	48	Left - 14.0/13.5/14.2 Right - 13.4/14.6/13.9	CR/IEN (Metaizeau Technique)	19
5	6	Female	Equivalent	Right	Left	Isolated radial neck fracture	−5/140–90/85	0/140–90/90	100	48	Left - 7.6/9.6/9.5 Right - 7.2/9.0/7.8	CR/ IEN (Metaizeau Technique)	16
6	8	Male	Equivalent	Right	Left	Plastic deformation of ulna, anterior dislocation of radial head	0/145–90/85	0/145–90/80	100	48	Left - 12.3/13.1/12.9 Right - 13.5/13.8/14.7	Corrective osteotomy	12
7	6	Male	Equivalent	Left	Left	Nondisplaced olecranon fracture with radial neck fracture	0/145–85/85	0/140–90/90	100	48	Left - 5.2/6.0/8.6 Right - 8.3/6.4/9.1	CR casting	15
8	10	Female	Equivalent	Left	Right	Humeroulnar dislocation	10/135–90/90	0/140–90/90	95	46	Left - 11.2/10.6/10.8 Right - 10.4/11.0/10.6	CR and casting	128

ROM (ext/flex-sup/pro). CR/IEN: Closed reduction and intramedullary elastic nailing, MEPS: Mayo elbow performance score, OES: Oxford elbow score, ROM: Range of motion

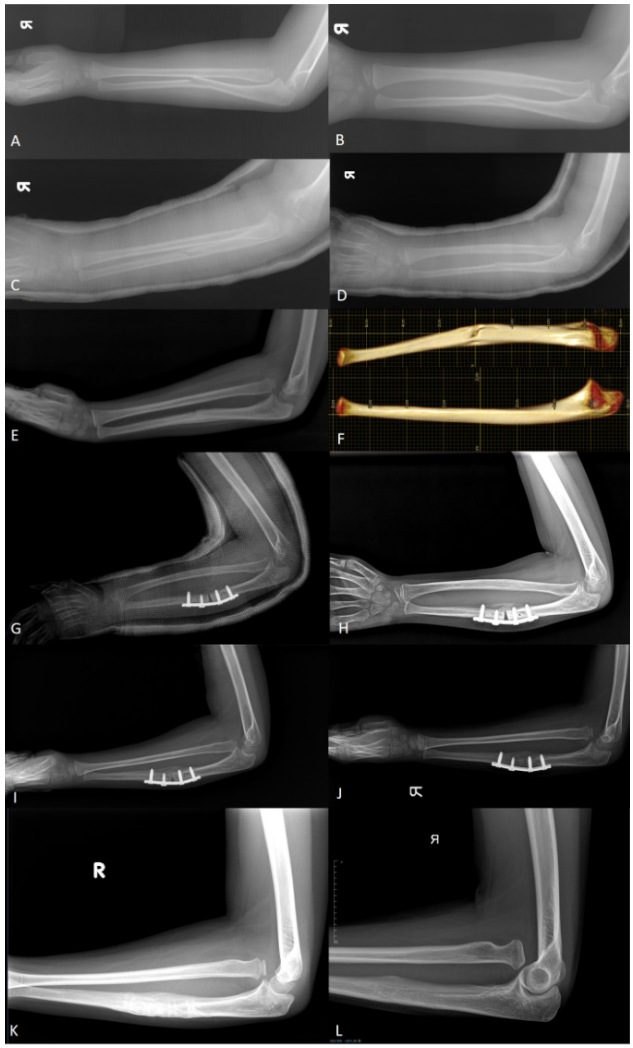

Figure 1. Radiographic follow-up of Case 1. (**a, b**) Posttrauma radiographies. (**c, d**) Closed reduction and cast application. (**e**) Radial head subluxation after the 6th week of initial trauma. (**f**) 3D computed tomography evaluation of injured and non-injured ulna. (**g**) Early postoperative radiography. (**h**) Postoperative 6th-week radiography. (**i**) Postoperative 3rd-month radiography. (**j**) Postoperative 6th-month radiography. (**k**) Postoperative 1st-year radiography after implant extraction. (**l**) Postoperative 9th-year radiography.

Cases 3, 4, and 5 had Monteggia equivalent injuries, which were isolated radial neck fractures. Cases 3 and 4 were Judet type 2, and Case 5 was Judet type 3 fractures. All patients' reduction was made via the Metaizeau technique. They were followed up for 98, 19, and 16 months, respectively, with no complication.

Case 6 presented with anterior dislocation of the radial head with plastic deformation of the ulna. Closed reduction attempts failed to reduce the radial head subluxation, making a surgical intervention necessary (Fig. 2a). A CORA-based corrective ulnar osteotomy was performed according to the preoperative planning with 3D CT images (Fig. 2b), and rigid stability was achieved by plate fixation (Fig. 2c). After correction of ulnar length, the radial head was still subluxated. Radiocapitellar joint exploration by Kocher incision revealed annular ligament incarceration (Fig. 2d). After reduction of annular ligament, radial head was reduced. Due to the strength of our fixation, we have been able to start early rehabilitation in the postoperative 1st week, as Hetthessy et al.[9] suggested. Full range of motion was present in the postoperative 6th month. No other complication was encountered after 12 months (Fig. 2e).

Case 7 had a nondisplaced intra-articular olecranon fracture with a radial neck fracture. Case 8 had a humeroulnar dislocation. Closed reduction was performed, and a long-arm cast was applied to both patients. There were no complications during the follow-up, and the cast was removed after 6 weeks, and the passive range of motion exercises was begun after that. All cases are summarized in Table 1.

In our cases, the range of motion of the injured sides was no less than 90% of the unaffected side. In addition, grip strength values were no less than 95% of the uninjured side, which were not inferior to the age-based grip strength values described in the literature.[10] The functional scores were also perfect for all patients. The only complication was an anterior dislocation of the radius in one patient after 6 weeks of her trauma, though it did not lead to a worse functional result after 99 months of follow-up. There were no neurologic or vascular deficits in any of the patients.

DISCUSSION

The forearm acts as a joint because of its ability of pronation/supination, which is directly affected by the length of the ulna, radius, and tension of the interosseous membrane.[11] The true and equivalent types of Monteggia share the same main treatment goal: the restoration of ulnar length.

Acute Monteggia Fractures

The treatment choice primarily depends on the stability of the ulnar fracture and secondarily on restoration of the radiocapitellar joint. The non-displaced and transverse ulnar fractures can be successfully treated conservatively, but while seeming innocent, ulnar plastic deformation should raise suspicion because of insidious shortening and angulation, which might end in radial head subluxation in the days to come. Relatively stable transverse or greenstick fractures and plastic deformations can be treated with closed reduction and casting as was in Case 2. Unstable fractures like oblique and spiral types should be treated surgically.[4,8] The reason for the subluxation of Case 1 could be explained by this instability as well. Although the patient had an oblique ulnar fracture, we decided on conservative treatment because we could obtain anatomical reduction. Insidious shortening of the ulna resulted in radial head subluxation. Casting should be performed in supination and hyperflexion to counterbalance the deforming effects, but care should be taken for the swollen elbow, which may result in neurovascular compromise. In such

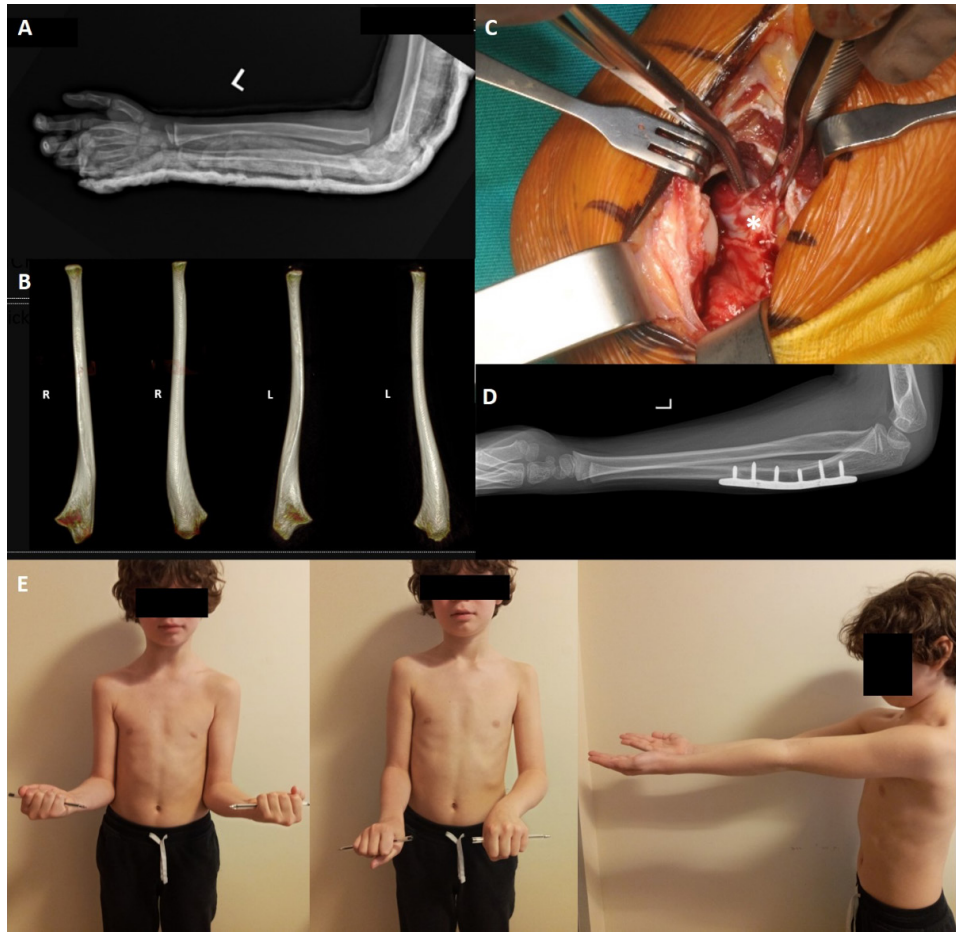

Figure 2. Radiographic follow-up of Case 1. (a and b) Posttrauma radiographies. (c and d) Closed reduction and cast application. (e) Radial head subluxation after the 6th week of initial trauma. (f) 3D computed tomography evaluation of injured and non-injured ulna. (g) Early postoperative radiography. (h) Postoperative 6th-week radiography. (i) Postoperative 3rd-month radiography. (j) Postoperative 6th-month radiography. (k) Postoperative 1st-year radiography after implant extraction. (l) Postoperative 9th-year radiography.

cases, the cast should be in a neutral position, and the upper extremity must be elevated for 3 days. When the swelling regresses, hyperflexed casting can be applied after checking the reduction status.[8] In conservative treatment, close follow-up is essential, which we were also scrupulous about because the loss of reduction rate can be as high as 20%.[12,13]

Surgical intervention should be decided according to the fracture pattern of the ulna. For example, intramedullary fixation should be the treatment of choice for short oblique fractures, which are length stable, but plate fixation should be reserved for the long oblique and comminuted ulnar fractures, which are length unstable.[8]

In acute isolated radial head fractures of the Monteggia equivalent group, we used the Metaizeau technique. In Yang et al.'s[14] study of isolated radial head fractures, the Metaizeau technique was sufficient in 76.2% of their population of 101 patients. Twenty-two of the remaining 24 open reductions were Judet type 4 fractures, which had unsatisfactory results. As was mentioned in the literature, the reductions achieved by the Metaizeau technique were associated with higher functional outcomes and lesser radial head necrosis and nerve palsy complications.[14] Case 3/4 was Judet type 2 and Case 5 was type 3 which were suitable for Metaizeau technique and no open reduction was necessary and no complication was seen in the follow-up.

Neglected Monteggia Fractures

The detected radial head dislocation is referred to as chronic or neglected if it is undiagnosed at the 4th week of the trauma; in addition, after 2 years of trauma, it is considered irreducible because of morphological changes occurring in the capitellum and the radial head.[10,11] Worse still, not only will the elbow be affected after a neglected case of Monteggia fracture, but also the distal radioulnar joint and the wrist will be disrupted in the long term.[15] Thus, correcting this deformity is essential for preventing future disabilities. The reasons behind the irreducibility and surgical algorithms are questioned in the literature. Previous studies are focused

mainly on the ulnar osteotomy type and localization, fixation methods, and the necessity of annular ligament repair.

In a neglected Monteggia fracture, first radiocapitellar joint should be evaluated. If the joint cannot be reduced by closed reduction, the joint should be evaluated for an incarcerated annular ligament or a buttonhole deformity of the radial head.[16] If no pathology is observed in the radiocapitellar joint, the next target should be the evaluation of ulnar length. On the contrary, we performed ulnar osteotomy first and radiocapitellar joint exploration second in Case 6. If the annular ligament incarceration was settled first, the required degree of ulnar osteotomy could have been less. As aforementioned, osteotomy type, localization, and fixation methods are thoroughly discussed in the literature. The ulnar osteotomy is widely accepted because it addresses the deformity's leading cause, as was shown in biomechanical studies.[17,18] In cases with intact annular ligament, ulnar osteotomy facilitates the reduction of the radial head when combined with dilatation and debridement of the fibrotic tissue around the annular ligament.[19] Ramski et al. reported that none of the patients treated with ulna-based surgery resulted in radiocapitellar joint instability.[12] Delpont et al. reported the most extensive proximal ulnar osteotomy series on 28 neglected Monteggia cases. In cases the osteotomy was performed within the 1st year, good long-term results were achieved after 6 years of follow-up.[6] On the other hand, the less demanding treatment group consisting of conservative and soft tissue adjustment surgeries showed 24% instability.[12] In a recent systematic review, the indication of ulnar osteotomy was decided on if the maximum ulnar bow was less than 4 mm and if the maximum ulnar bow was in the distal 40% of the ulna.[16]

As for the osteotomy type, overcorrection osteotomy, described as transverse opening wedge osteotomy by Hirayama et al.,[5] was associated with better functional outcomes than simple transverse osteotomy.[3] Similarly, Inoue and Shionoya found significantly higher functional scores in the overcorrection group because residual subluxations were still encountered in simple transverse osteotomy patients.[20] The osteotomy site is predominantly located on the proximal metaphysis of the ulna, which has resulted in a higher union rate.[4,11,21] Ulnar non-union was mainly associated with patient's age and the delay to surgery. The osteotomy site's effect on union rate is not clear in reported systematic reviews.[11,16] As the authors of the study, we embraced the CORA-based osteotomy which has the advantage of preoperative planning via 3D CT.[22] In addition to the extension deformity, coronal or rotational deformities of the ulna may also exist and play a role in the mechanism of radial head dislocation. To overcome these issues, bilateral 3D CT scanning was used, and the deformity of the ulna was demonstrated in all aspects. As the authors, we preferred CORA-based osteotomy in cases 1 and 6, and no pseudoarthrosis was encountered. Tan et al.'s systematic review reported that proximal osteotomy is superior to CORA-based osteotomies. This assertion was based on the interosseous membrane tension. By doing the osteotomy proximally, interosseous membrane tension is maximally asserted to the radial head to prevent subluxation. CORA-based osteotomies lack this advantage.[11,16]

The preferred fixation methods were K-wire, plate, and external fixation. K-wire results were good but not without failures.[4] We preferred plate fixation because of its stability, supported by recent studies.[23] He et al.[23] also preferred locking compression plate in 88.2% of their neglected patients because of its stability (n: 17). On the other hand, external fixation has the advantage of being adjustable. For example, if radial head subluxation were to be encountered during the follow-up, which is not a rare finding, an external fixator could be adjusted to increase the ulnar length.[24] Ulnar osteotomy with external fixator systems may allow for a gradual lengthening of the ulna, and spontaneous reduction of the radial head may be achieved with this method.[25] Bor et al.[25] reported that closed reduction was achieved in all four cases; however, Di Gennaro et al.[26] did not report such a high success rate. In addition, this technique requires the patient to live with the external fixator for several months, which may become problematic for the pediatric patients. Moreover, it can also be used as a temporary fixation method to achieve the ideal positioning of the ulna after the osteotomy.[27] They can also be used to facilitate plate fixation.[28]

Open radial head reduction and ulnar osteotomy combinations are enough for most of the neglected Monteggia fractures. If radial head is still not reduced, radial head osteotomy can be considered, but this technique was not embraced in the literature and one reported functional outcome was not satisfactory.[29] Radial osteotomies may be performed if ulnar lengthening is insufficient due to soft tissue tension and it can help avoid possible nerve injury.[16]

The next step for the unreduced radial head should be annular ligament reconstruction (ALR) which was also widely debated. No strong evidence is present to support the use of ALR in the literature.[16] Utilization of ALR alone resulted in high subluxation rates.[30] Moreover, two-stage approach may eliminate the need for ALR.[31] ALR was used in 58.5% of the cases in the literature but mostly incorporated with other techniques, mainly ulnar osteotomy.[11] For ALR, triceps fascia graft is the most preferred, but triceps tendon, annular ligament remnant, forearm fascia, palmaris longus, or ulnar periosteum may also be used. Rahbek et al. compared the results of ulnar osteotomies with and without ALR. No significant difference was reported.[21] In light of these findings, Bhaskar et al.[32] proposed an algorithm. After ulnar osteotomy, the radial head reduction was confirmed under fluoroscopy in full pronation. If subluxation occurs, the ulnar length should be adjusted. If no improvement is achieved, ALR should be the next step.[32] On the contrary, the pediatric annular ligament is reported to be so thin that, even if it is entrapped, fluoroscopy views may result in an image that "appears" as a congruent reduction. Hence, routine radiocapitellar joint exploration was recommended in the study

by Tan et al.[33] In a case series by Eamsobhana et al.,[34] age was suggested as a negative prognostic factor. Moreover, in a more recent study by Ko et al.,[35] the authors suggested that the ulnar osteotomy and ALR should be utilized judiciously in patients when the skeletal age of the patient is older than 14 and 11.5 in boys and girls, respectively.

ALR's common complication was the limitation of pronation by a mean of 20°.[36] Due to this functional deficit, Lu et al.[37] reported their experience of annular ligament repositioning in 23 neglected cases. Their hypothesis was based on the difficulty of providing the appropriate tension for the annular ligament in reconstruction. Their functional results, range of motion, and radiographic outcomes after 18 months of follow-up were comparable to reconstruction cases in the literature.[37] Gyr et al.[38] reported 15 patients with ALR at a mean follow-up of 30 months. Four re-subluxations, one arthrofibrosis, and one heterotopic ossification were encountered in different patients. Although the pronation/supination was limited in some patients, their flexion/extension was improved. They concluded that this procedure has a much-better long-term outcome for elbow function than neglecting the radial head dislocated.[38]

The last resort was reserved in the recent systematic review for the transcapitellar K-wire fixation if the radial head was not reduced. Unfortunately, transcapitellar fixation was used in 31.6% of the patients in the literature and was significantly associated with unsatisfactory results, and Delpont et al. reported early radiographic signs of arthrosis.[15,16] Nevertheless, this technique was used as a last resort in the studies; thus, these unsatisfactory results could be attributed to the complexity of the cases.[16]

In extreme cases where the loss of rotational movements interferes with activities of the daily living, radial head excision may be a salvage option, but complications such as instability, weakness, and synostosis are reported to be inevitable. Therefore, many authors agreed that radial head resection should be avoided if possible.[3]

The most common complications of pediatric true/equivalent Monteggia fractures are elbow stiffness, radial head subluxation, nerve palsies, malunion, non-union, and synostosis.[39] Among the nerve palsies, the posterior interosseous nerve is the most commonly affected, as its course is close to the radial head to enter the supinator muscle. The nerve palsies reported in the literature spontaneously resolved 2–9 weeks after trauma.[40] In the less unfortunate case series of Stein et al., 7 out of 11 patients suffered from posterior interosseous nerve palsy, which required surgical decompression. In addition, they suggested exploration and decompression if no recovery was observed after 12 weeks.[40]

The non-union rate in Monteggia fractures is <2%.[41] The only exception is the Monteggia type IV fractures, which have a significantly higher rate of non-union. When a non-union is encountered, poor soft tissue envelope and infection should be suspected.[41] Primary bone grafting for the gaps at the osteotomy site is also a debate; although some studies did not mention this detail, it is described in a few studies for the gaps of 2–10 mm.[32,42]

Radioulnar synostosis leads to unsatisfactory functional results due to the limitation of forearm rotation. To evade this complication, avoidance of a single incision for exposure of both bones and early active range of motion exercises should be recommended.[39] In case 6, two different incisions were used, passive physical rehabilitation was begun after the 1st week postoperatively, and no synostosis nor elbow stiffness was observed.

Radial head dislocation was experienced in case 1, even after CORA-based ulnar osteotomy. If the patient consent had been obtained, the next step would be the surgical exploration of the radiocapitellar joint because we suspected "buttonholing" of the radial head through the anterior capsule. After all, the fat pad sign was not evident in radiographs after the initial trauma. The fat pad sign reflects the joint hematoma in the X-ray. However, in the case of "buttonholing," the joint capsule is perforated by the radial head, and the resulting hematoma is dissipated.[43,44] Still, due to the patient's improved range of motion and the ability to participate in sports activities, the family did not agree to revision surgery. Suzuki et al. compared the functional outcomes of dislocated radial head patients after corrective osteotomy surgery.[45] The conservative group had achieved better functional results than the re-operated group. In concordance with Suzuki et al.'s[45] conclusion, even after 8 years of first trauma, our patient had an excellent functional level and participation in all sports activities.

The main limitation of our case series is our small and heterogeneous population. The second limitation is the retrospective nature of the study. Most series in the literature carry the same limitation due to the rarity of the target population and have used a variety of treatments. Moreover, our study's distinct result is that the patients' grip strengths were similar to their uninjured extremities and the values previously reported in the literature in conservatively or surgically treated patients, even in patients with the re-dislocated radial head.[10]

Conclusion

In conclusion, the true/equivalent Monteggia fractures' main treatment goal is to restore the ulnar length. If closed reduction is successful after the initial trauma, the patient should be closely followed up for radial head subluxation. If radial head subluxation is encountered, bowing of the ulna, annular ligament incarceration, or buttonholing of the radial head should be suspected. In neglected cases, ulnar osteotomy and radiocapitellar joint exploration can be the first step treatment. As the second line of treatment, ALR and radial osteotomies may be considered. ALR is controversial due to pronation/

supination limitation, but Lu et al.'s annular ligament repositioning in neglected cases can be a more promising solution for this widely debated problem. As the authors of this study, we prefer closed or open reduction of the radiocapitellar joint. If not sufficient, we advise proceeding with ulnar osteotomy. If radial head still is not reduced, more complex and less promising techniques such as ALR, radial osteotomies, and as a last resort, transcapitellar pinning should be utilized.

Ethics Committee Approval: This study was approved by the Koc University Hospital, Clinical Research Ethics Committee (Date: 22.02.2021, Decision No: 2021-102

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ORİJİNAL ÇALIŞMA - *ÖZ*

Pediatrik gerçek ve ekivalan Monteggia kırıklarında fonksiyonel sonuçlar ve güncel literatüre bakış

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AMAÇ: Bu çalışmanın amacı, pediatrik popülasyonda gerçek ve ekivalan Monteggia kırıklı çıkıklarındaki fonksiyonel sonuçlarımızın bildirilmesidir. Bunun yanında tedavi seçenekleri hakkında bir literatür incelemesi de yaptık.
GEREÇ VE YÖNTEM: 2009-2021 tarihleri arasında beşi cerrahi, üçü konservatif tedavi edilen hasta saptandı. Bu hastaların altısı kız çocuğu, ikisi ise erkek çocuğuydu. Tedavi anında ortalama yaş 7 idi. Ortalama takip süresi 55 hafta (aralık, 12-128) olarak bulundu. Mayo Elbow Performance Score (MEPS) ve Oxford Elbow Score (OES) sonuçların değerlendirilmesinde kullanıldı. Eklem hareket açıklığı ve kavrama güçleri de değerlendirildi.
BULGULAR: Bu sekiz hastada, iki Bado tip I ve altı Monteggia ekivalan yaralanması saptandı. Bado tip I yaralanmalar için kapalı redüksiyon ve alçılama birincil tedavi olarak kullanıldı. Fakat bu hastaların birinde redislokasyon gelişmesi üzerine cerrahi tedaviye geçildi. Aynı hastada cerrahi sonrasında ikinci kere dislokasyon gelişmesi üzerine konservatif tedaviyle takip edildi. Üç Monteggia ekivalan yaralanma kapalı redüksiyon ve alçılama ile komplikasyonsuz tedavi edildi. Bir hastada ulnanın plastik deformasyonuyla beraber radius başının anterior çıkığı vardı ve bu hastada CORA'ya uygun düzeltici ulnar osteotomi uygulandı.
TARTIŞMA: Monteggia yaralanmaları için ana tedavi yöntemi ulnar uzunluğun geri kazanılmasıdır. 3 boyutlu rekonstrüksiyonlu bilateral BT görüntüleme tedaviyi hastaya göre özelleştirmek için preoperatif planlamada kullanılabilir. Radius başı subluksasyonunun erken tespiti ve gereken girişimin yapılması için geç kalınmaması amacıyla yakın gözlem elzemdir.

Anahtar sözcükler: Monteggia; Monteggia ekivalan; pediatrik kırık; üst ekstremite deformitesi.

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